English translation of application text as originally filed

Method and device for producing a tubular workpiece, especially a shock-absorber piston rod, and a workpiece of that kind

Specification

The present invention relates to a method for producing a tubular workpiece, especially a shock-absorber piston rod, wherein, starting out from a tubular initial workpiece, a first area of the initial workpiece is reduced in a first step by a radial forming process for reducing its outer diameter, and a transition area, extending at an angle relative to the longitudinal axis of the tubular initial workpiece, is formed, the transition area extending between the first area of the tubular initial workpiece having the reduced diameter and a non-reduced second area following the transition area, and to a workpiece of that kind and a device for producing such a workpiece.

A method of that kind is known and is used for producing cold-formed workpieces, for example a shock-absorber piston rod. Such shock-absorber piston rods are employed especially in certain front-axle designs of motor vehicles where the shock absorber has to fulfill a wheel-guiding function too. The shock-absorber piston rod

then needs to be given a larger diameter, and for weight-saving purposes these rods are then made from a tubular material and are thereby hollow.

The design of the known shock-absorber piston rod exhibits, at a spacing from the upper end near the car body, a substantially rectangular shoulder that serves to mount the shock absorber of the vehicle. In the case of the known piston rods, which are cold-formed by rotary swaging, the shoulder is formed by initially reducing the body-end portion of the initial tube and then forming the transition area to that portion of the tube, which was not subjected to the rotary swaging operation and which still exhibits the initial diameter of the initial workpiece, with an angle of 45°. This is necessary in order to keep the wall thickness of the initial tube of the shock-absorber piston rod substantially constant so as to not weaken the wall of the workpiece. Considering, however, that the final shock-absorber piston rod has got to exhibit a rectangular shoulder at this point, i.e. an adaptor sleeve that comprises an abutment surface extending at a right angle relative to the longitudinal axis of the piston rod is pressed on said transition area that extends at an angle of approximately 45° relative to the longitudinal axis of the piston rod,

Such an adaptor sleeve constitutes an extra part which results in additional production and assembly costs. In addition, close fit tolerances must be maintained in this case in order to guarantee the exact position of the adaptor sleeve on the piston rod.

Now, it is the object of the present invention to improve a method for producing a workpiece, especially a shock-absorber piston rod, and a workpiece of the aforementioned kind, so that a workpiece comprising a substantially rectangular shoulder can be produced from a tube in a simple way without the use of an adaptor sleeve.

The invention achieves this object by a second process step, following the first process step, in which the transition area of the initial workpiece is cold-formed to obtain a substantially rectangular shoulder.

The features according to the invention provide a favorable way of producing, in a simple way and solely by cold-forming steps, a tubular workpiece with a substantially rectangular shoulder, especially a shock-absorber piston rod, from a tubular initial workpiece. Due to the fact that the rectangular shoulder can be produced directly by the method of the invention, using an adaptor sleeve, which is costly in terms of production and assembly, is therefore no longer necessary for the production of a workpiece made according to the method of the invention, which advantageously reduces its production costs as a whole.

Cold forming the initial workpiece to the final product, which now advantageously consists of a single piece, provides the advantage that no, or only a slight weakening of the wall of the initial workpiece occurs.

According to an advantageous further development of the invention, the forming operation of the second step is an orbital forming operation, effected especially by at least one of a circular movement and a tilting movement, or an axial pressing operation.

Other advantageous further developments of the invention are the subject-matter of the depending claims.

Further details and advantages of the invention will become apparent from the exemplary embodiment that will be described hereafter with reference to the drawings in which:

Fig. 1 shows one embodiment of a tubular workpiece after a first process step;

Fig. 2 shows the workpiece of Fig. 1 after the second process step; and

Figs. 3 and 4 show one embodiment of a device for producing a workpiece.

In order to arrive at the intermediate product, illustrated in Fig. 1, of the production process of a workpiece, indicated by reference numeral 1, the workpiece 1 having a rectangular shoulder 2, the upper area of a tubular initial workpiece 3 is first reduced by a cold-forming process, for example a rotary swaging process, which is known as such and which, therefore, will not be described herein in more detail, whereby that first area 3a of the tubular initial workpiece 3 is reduced to a smaller diameter than a non-reduced second area 3b. Preferably, a transition area 3c between the first and the second areass 3a and 3b is again formed as a circumferential inclined surface with an inclination of approximately 45° relative to the longitudinal axis A of the initial workpiece 3.

As is readily apparent from Fig. 1, the wall 5 of the tubular initial workpiece 3, part of which is shown in cross-section, is reduced by the cold-forming process either not at all or only insignificantly, so that no weakening of the material of the initial workpiece 3 occurs in the transition area 3c. Now, in order to convert that intermediate product into the final product illustrated in Fig. 2, i.e. the tubular workpiece 1 with the substantially rectangular shoulder 2, the invention provides to

subject the transition area 3c to a forming operation, especially an orbital forging or axial pressing operation. The orbital forging operation may conveniently be performed by employing an orbital forging process using a circular movement, a tilting movement or a combined circular and tilting movement of a corresponding die. Forming methods of that kind are known to the person skilled in the art and will therefore not be described herein in more detail.

As it can be seen from the representation of the wall 5 of the tubular initial workpiece 3, no weakening of the wall 5 in the area of the shoulder 2 occurs in this case, either.

The method is advantageously and especially well suited for the production of a shock-absorber piston rod with a rectangular shoulder. In addition to such shock-absorber piston rods, the invention also lends itself to producing other workpieces, which need to have a rectangular or a substantially shoulder, from a tubular initial workpiece in a single piece.

Figs. 3 and 4 now show one embodiment of a device, indicated generally by reference numeral 10, for producing the workpiece 1 with a substantially rectangular shoulder 2. For carrying out the first process step mentioned above, namely for producing the transition area 3c between the first and the second areas 3a and 3b of the initial workpiece 3, the device 10 comprises a reducing unit 11 designed in this case as a rotary swaging tool with a plurality of rotary swaging dies 12. The rotary swaging dies 12 act upon the initial workpiece 3 in radial direction R. Each rotary swaging die comprises an inclined forming surface 13, the inclination of which relative to the longitudinal axis A of the initial workpiece 3 is again approximately equal to 45°, corresponding substantially to the inclination of the inclined surface of the transition area 3c to be produced.

Once the inclined transition area 3c has been formed by a reducing process known as such, which therefore will not be described herein in more detail, especially by rotary swaging, the initial workpiece 3 is transferred from the reducing unit 11 of the device 10 described above to a further forming unit of the device 10, designed in the present case as an orbital forming unit 15, where the second process step is to be carried out. That orbital forming unit 15 comprises an orbital die 16, which performs an orbital movement about a longitudinal axis A, acting upon the transition area 3c of the initial workpiece 3 by its working surface 17 until the substantially rectangular shoulder 2 has been formed.